Toward Real Time Compensation with a Combined DFP/AFCS System

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Over the past decade, extensive work has been performed at JPL on the use of a Deformable Flat Plate (DFP) and Array Feed Compensation System (AFCS) to correct for the gravity-induced distortions on a large reflector antenna. The DFP is placed in the beam path and deformed in order to compensate for the gravity-induced distortions as the antenna moves in elevation. Actuators controlling the plate surface are driven via a look-up table. Values in the look-up table are derived using the measured antenna distortions, ray tracing, and a structural finite element model of the DFP. The Array Feed Compensation System (AFCS) consists of a small array of horns, low noise amplifiers, down converters, and digital signal processing hardware and software for optimally combining the signals received by the horns. Each system acting alone and a combined system consisting of both the DFP and the AFCS were demonstrated on the Deep Space Network (DSN) 70-meter antenna. The combined system worked better than either one of the systems acting alone. However, even in the combined experiment, each system was operated independently in that there was no feedback from the AFCS to the DFP.

The purpose of this paper is to describe a set of experiments whose intent is to demonstrate the feasibility of real time compensation using the AFCS to update the DFP actuator positions and repoint the antenna, in order to compensate for deformations due to either gravity, wind or thermal perturbations. This is a precursor to a more complete system for compensating any time varying (not necessarily gravity dependent) deformations.

There were several parts to the experiment, carried out during recent tracks of Ka-band signals from the Cassini spacecraft. First, known subreflector displacements were applied to the antenna and the value of the displacement passed to the DFP computer. The computer then estimated and applied the actuator positions to correct for this offset. Both the "signal-to-noise ratio" (SNR) loss due to the subreflector displacement as well as the improvement with the updated actuator positions was recorded. Next, both pointing offsets and subreflector displacements were applied, and the AFCS was used to estimate the subreflector displacement and pointing offsets simultaneously, based on azimuth and elevation dependent "least-squares" models developed from previously obtained data. Third, making use of the AFCS estimates, the required antenna pointing corrections and subreflector displacements were calculated and input into the antenna system, and the correcting actuator positions computed and applied to the DFP. The SNR was measured once again, and the improvements resulting from joint AFCS-DFP compensation determined. During the next set of observations similar experiments will be performed using a closed loop system that will provide for continuous updates to correct pointing offsets and subreflector motion.